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Effects of honey and floor type on physiological responses, haematology, plasma biochemistry and carcass yield in broiler chickens under tropical conditions

Abioja, M.O. *, Akinjute, O.F., Agboola, O.O., Ilesanmi, O.M., Taiwo, A.A. and Adeyeoluwa, M. A.

Department of Animal Physiology, College of Animal Science and Livestock Production; Federal University of Agriculture, PMB 2240 Abeokuta, Nigeria

*Corresponding author (Email: abiojamo@funaab.edu.ng; Phone: +234-803-395-2155)

ABSTRACT

Administering honey in drinking water has been found to help broiler chickens cope with heat stress. Floor type may also affect heat loss in broiler chickens. Effects of honey and floor type on physiological responses, blood parameters and organs in broiler chickens were determined during hot-dry season under humid tropical environment. One hundred and sixty *Marshal* broiler chickens aged 21d were used in a 4-week experiment. Birds were allotted to four treatments: rearing on deep-litter floor with 0 (DL0H) and 20ml honey/L water (DL20H) or on serrated floor with 0 (SF0H) and 20ml honey/L water (SF20H) from d21–d49. Data on physiological responses, blood parameters and carcass yield were subjected to analysis of variance (ANOVA). 20H treatment significantly ($P<0.01$) lowered rectal temperature (RT), heart rate (HR) and skin temperature under wings (STWI) compared to 0H. Birds on SF had significantly ($P<0.05$) lower RT, respiratory rate (RR), HR, skin temperature under wings, on wattle (STWA) and chest (STCH), and relative weight of head and neck but higher lymphocyte count compared to DL. There were significant ($P<0.05$) interactive effects of honey and floor type on RT, RR, STWA, globulin and aspartate amino transferase. Combining honey with serrated floor will further improve heat loss in chickens. For better welfare and thermoregulation during hot spells, honey at 20ml/L drinking water could be offered to broiler chickens. Using serrated floor, rather than deep-litter may help the chickens lose more body heat and thereby cope during hot periods under tropical environment.

Keywords: Anti-oxidant, anti-stress, heat stress, housing, pen temperature

INTRODUCTION

The challenge of heat stress (HS) is of note in broiler production especially in the tropics (Lin *et al*., 2006; Sunil *et al*., 2011), where broiler chickens are mainly reared in open-sided poultry houses (Czrick and Fairchild, 2008). There has been great improvement in growth rate of broiler chickens above what was obtained in 1950s because of success in selection programmes over the years. Achieving high rate of muscle accretion in broiler lines is a leap in the direction of bridging the gap in protein demand and supply all over the world. However, the scourge of HS is a constant threat to the aim of rearing chickens for meat within a short span of time (Daghir, 1995). The challenge usually reaches the threshold during hot seasons when environmental temperature rises above 30^{o}C (WMO, 2015). Hot season is characterized by temperature higher than thermal comfort (18-22^{o}C) of broiler chickens. The birds employ non-evaporative heat loss (by conduction, convention and

radiation) as ambient temperature increases in the poultry house. However, this mechanism becomes exhausted as the environmental temperature increases further, soaring above the thermal comfort for the birds. When the 'upper critical temperature' is exceeded, birds lose heat actively by panting. Besides behavioural responses, birds react physiologically to the discomfort by exhibiting certain cascade of events along hypothalamic-hypophysial-adrenal (HPA) axis triggering sympathetic nervous system, which ends in the release of glucocorticoids (Garriga *et al*., 2006; Star *et al*., 2008; Quinteiro-Filho *et al*., 2010; Quinteiro-Filho *et al*., 2012). Circulating corticosterone is cytotoxic and leads to loss of growth and immunosuppression in animal (Siegel, 1995). Panting results in loss of bicarbonate and acid-base perturbations with resultant *respiratory alkalosis* (Mahmoud *et al*., 1996; Grieve, 2003). Of its numerous adverse effects are increase in body temperature, respiratory rate and pulse rate, decrease in growth performance and immunity, variations in blood cell counts and metabolites Altan *et al*. (2000).

The use of honey as anti-stress in chickens has received a boost with the report of its content of phenols and various phytochemicals that possess anti-oxidant properties (Oke *et al*., 2016; Adekunle *et al*., 2017). Molan (2001) in the review on why honey is effective as a medicine stated that some of the components of honey are substances known to have physiological actions that would explain many of its therapeutic effects. In addition, research on honey has shown directly that it has physiological actions that would give therapeutic effects. Abioja *et al*. (2012) stated that 20ml honey dissolved in a litre drinking water had positive effect on respiratory and heart rates, calcium metabolism, bone formation and some internal organs in stressed broiler chickens. Honey has been reputed to protect against oxidative stress in GIT, liver, kidney, pancreas, eye, plasma, red blood cells and reproductive organs in rats (Erejuwa *et al*., 2010; Mohammed *et al*., 2011; Zaid *et al*., 2011; Erejuwa *et al*., 2012). Broiler chickens are commonly raised on deep-litter floor in most areas of the world, but the use of cage for broiler is becoming common (Shields and Greger, 2013). Type of floor has been reported to influence live weight, feed intake, protein efficiency and feed conversion ratio in broiler birds reared during winter (Bilal *et al*., 2014; Simsek *et al*., 2014) and summer (Simsek *et al*., 2014). Aslam Athar *et al*. (1990) had however reported that there were no differences in weight gain, feed consumption and dressing percentage in broilers whether they were raised on cages, floor or transferred from one type of floor to another during rearing. Shields and Greger (2013) once opined that cages may lead to increased levels of fear and stress in the birds. It is not clear if honey with different floor type will improve the physiological responses and growth in broiler chickens during hot season. Therefore, this study aimed at determining the effects of honey and floor type on physiological, haematological and plasma biochemical responses and carcass yield in broiler chickens during hot-dry season.

MATERIALS AND METHODS

Meteorological observations

Data on pen temperature and relative humidity in different units were monitored using thermo-hygrometer at 08:00, 14:00 and 19:00h daily.

Experimental animals and management

Day-old unsexed broiler (*Gallus gallus domesticus*) chicks (of *Marshall* strain) purchased from a reputable hatchery for the experiment were brooded for 21 days. One hundred and sixty broiler chickens on d21 were transferred into pens and reared up to d49. All the birds were housed in the pens in

the same house at density 18kg/m^2. The birds were allotted to four groups balanced for weight. Birds in groups I and II were kept on wood shaven deep-litter floor (DL) while group III and IV were kept in serrated floor pens (SF). Drinking water containing no honey was given to group I (0H-DL) and group III (0H-SF) birds while groups II (20H-DL) and IV (20H-SF) birds received 20ml honey per litre drinking water. There were four replicates with 10 birds per replicate. Water and feed were made available *ad libitum* throughout the experimental period. The diet composition of the birds on honey treatment was adjusted to account for the metabolizable energy in the honey. The composition of feeds given is shown in Table 1.

Data collection

Physiological responses

Rectal temperature (RT) of two birds randomly selected out of each replicate was measured with a digital thermometer (0.1^oC accuracy) inserted into the rectum (colon) of the birds for 1 minute as previously described by Yahav and McMurtry (2001). Temperature measurement was taken twice in week 4, 5 and 6. Respiratory rate (RR) of the birds was taken as the number of flank movement per minute. A cycle of flank movement involves both inward and outward motion during breathing. Stethoscope was used to take the HR of birds. The stethoscope was placed on the chest region of the birds to monitor the heart rate (HR) per minute. The reading was taken for 15 seconds then multiplied by 4 to give the value per minute. Measurement for RR and HR were done twice during 4th and 5th week of age. Infrared thermometer was used to measure the temperature under the wings, on the wattle and chest on d49. Data on these physiological parameters were collected between 14:00 and 16:00 h during the experimental period.

Table 1: Composition of experimental diets

Ingredients	Honey (%)	No honey (%)
Maize	56.0	58.0
Soybean meal	30.0	32.0
Wheat offal	6.7	2.7
Fishmeal	2.0	2.0
Bone meal	3.0	3.0
Oyster shell	1.5	1.5
Lysine	0.15	0.15
Methionine	0.15	0.15
*Premix	0.25	0.25
Salt	0.25	0.25
	100	**100**
Calculated:		
Metabolizable energy (Kcal/kg)	2892.2	2924.4
Crude protein (%)	20.46	20.96
Crude fibre (%)	3.21	3.01
Ether extract (%)	3.53	3.53
Calcium (%)	1.49	1.49
Available phosphorus (%)	0.56	0.57
Lysine (%)	1.23	1.28
Methionine (%)	0.48	0.48

Haematological responses

Blood samples were collected from two randomly picked birds from each replicate weekly throughout experimental period via brachial vein on d35, d42 and d49. Packed Cell Volume (PCV), Red Blood Cell count

(RBC) and White Blood Cell count (WBC) was determined according to Lamb (1991). Blood collected in EDTA bottles was placed in a micro-haematocrit centrifuge and spun for 5 minutes at a revolution of 4000 rpm. The PCV value was determined by measuring the height of the red cell column and expressing this as a ratio of the height of the total blood column using micro-haematocrit reader. RBC count was done by diluting the blood sample with 0.9% NaCl. The diluted blood was mounted on a haemocytometer and the number of erythrocytes counted microscopically. Blood smear was stained using May-Grunwald and Giemsa stains approximately 4 hours after preparation with methyl alcohol fixation. Leucocytes differentials (heterophils, lymphocytes, eosinophils, monocytes and basophils) was counted for each smear and heterophil-lymphocyte ratio (H:L) was calculated according to Yalcin *et al*. (2005).

The erythrocytic indices (mean corpuscular haemoglobin (MCH), mean corpuscular volume (MCV), and mean corpuscular haemoglobin concentration (MCHC)) were calculated using the formulae below:

MCH=Haemoglobin (g/dl)/Red blood cell count ($\times 10^{12}$)

MCHC = Haemoglobin (g/dl)/Haematocrit (%)

MCV= Haematocrit (%)/ Red blood cell count ($\times 10^{12}$)

Plasma biochemistry

Total plasma protein was determined according to Colowick and Kaplan (1955) while serum albumin and globulin was determined using bromocresol purple method of Varley *et al*. (1980). Plasma concentration of uric acid (UA) was measured by commercial colorimetric diagnostic kits (Lin *et al*., 2004). Plasma alanine aminotransferase (ALT) and aspartate aminotransferase (AST) were analysed spectrophotometrically by using commercially available diagnostic kits (RANDOX® Test Kits).

Carcass yield

Eight chickens per treatment were slaughtered for carcass yield analysis on d49. Dressed and eviscerated weights of the birds were taken. Cut-parts and organs (head, neck, wings, back, breast meat, shank, thigh, drumstick, gizzard and liver) were weighed and relative weight was calculated in percentage of live weight.

Data analyses

Data collected were subjected to two-way analysis of variance using SAS (2002) computer statistical package. Means were separated with Tukey HSD test. Means were considered significantly different at p less than or equal to 0.05. Statistical model employed is:

$Y_{ijk} = \mu + H_i + F_j + HF_{ij} + \Sigma_{ijk}$

where $Y_{ijk} = \mu$ is the population mean; H_i is the i^{th} effect of dosage of honey (i = 0 , 20ml honey/L water); F_j is the j^{th} effect of floor type (j = deep litter, serrated floor); HF_{ij} is interactive effect of honey and floor type; and Σ_{ijk} is the residual error.

RESULTS

Summary of the meteorological factors during the experiment is presented in Table 2. The mean, minimum and maximum temperatures were 31.4, 26.3 and 36.5ºC respectively while the relative humidity was 80.7%.

Effects of honey and floor type on rectal temperature, respiratory rate and heart rate are presented in Table 3. Honey in drinking water of broiler chickens significantly ($p<0.01$) affected rectal temperature. Birds on 20H had lower (42.2ºC) body temperature than those in 0H group (42.5ºC).

Table 2: Summary of climatic observations during the experiment

Factor	Average
Minimum temperature (°C)	26.3
Maximum temperature (°C)	36.5
Mean temperature (°C)	31.4
Relative humidity (%)	80.7
Temperature-humidity index	98.8

Table 3: Effects of honey and floor type on rectal temperature, respiratory rate and heart rate in broiler chickens during hot-dry season

	Honey			**Floor**			**Honey x Floor**				
Parameter	**0H**	**20H**	***p***	**DL**	**SF**	***p***	**DL-0H**	**DL-20H**	**SF-0H**	**SF-20H**	***p***
Rectal temperature, ^{o}C	42.5± 0.07^{a}	42.2± 0.07^{b}	0.009	42.7± 0.07^{a}	42.0± 0.07^{b}	0.000	42.7± 0.10^{a}	42.6± 0.10^{ab}	42.3± 0.10^{b}	41.8± 0.10^{c}	0.019
Respiratory rate, breaths/min	129.1 ±2.28	134.9 ±2.28	0.079	138.8 ±2.28^{a}	125.3 ±2.28^{b}	0.000	147.3 ±3.22^{a}	130.3 ±3.22^{b}	128.0 ±3.22^{b}	122.5 ±3.22^{b}	0.001
Heart rate, beats/min	199.6 ±2.96^{a}	187.4 ±2.96^{b}	0.005	198.4 ±2.96^{a}	188.6 ±2.96^{b}	0.023	203.3 ±4.19	193.5 ±4.19	196.0 ±4.19	181.3 ±4.19	0.553

^{a,b}Means within the same row under different factors with different superscripts differ significantly (P<0.05)

Floor type had significant (p<0.001) effect on rectal temperature of broiler chickens. Chickens on deep-litter had higher rectal temperature than those on serrated floor. There exists significant (p<0.05) interactive effect between honey and floor type on rectal temperature. Broiler chickens on serrated floor offered 20H in water had the lowest rectal temperature (41.8^{o}C) while the hottest temperature was recorded in chickens that received 0H on deep litter floor (42.7^{o}C). Honey had no significant (p>0.05) effect on respiratory rate in broiler chickens. However, the effect of floor type was significant (p<0.001), with birds on serrated floor recording lower (125.3 breaths/min) respiratory rate than those on deep-litter floor (138.8 breaths/min). Interaction between honey and floor type was significant (p<0.01) on respiratory rate of broiler chickens. Rearing broiler chickens on deep litter floor with no honey in water resulted in higher respiratory rate than other three treatment groups. Heart rate in broiler chickens was significantly affected by honey (p<0.01) and floor type (p<0.05). Birds in 0H group recorded higher heart rate than those in 20H group. Lower heart rate was observed in chickens on serrated floor than birds on deep litter floor. Heart rate in broiler chickens was not significantly (p>0.05) affected by interaction between honey and floor type. Effect of honey in drinking water of broiler chickens was significant on skin temperature (Figure 1) under the wings (p<0.01*) but* not on wattle (p>0.05) and on chest (p>0.05). 20H treatment lowered the temperature under the wings compared with 0H. Skin temperature (Figure 2) on the three spots were significantly (p<0.001) affected by floor type with birds on deep litter recording higher values. Significant interactive effect of honey and floor type only exists for skin temperature on the wattle (p<0.05; Figure 3). Broiler chickens that received 20H on serrated floor had lower wattle temperature than those on deep litter (both 0H and 20H).

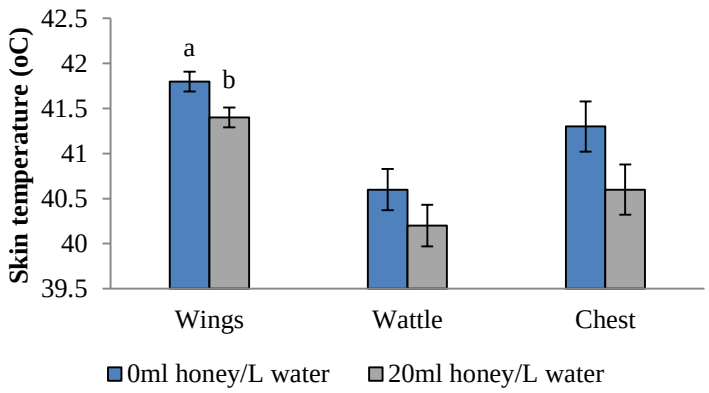

Fig. 1. Effect of honey in drinking water on skin temperature under wings, on wattle and chest of broiler chickens during hot-dry season
[a,b] Means represented by bars with different letters differ significantly (P<0.05)

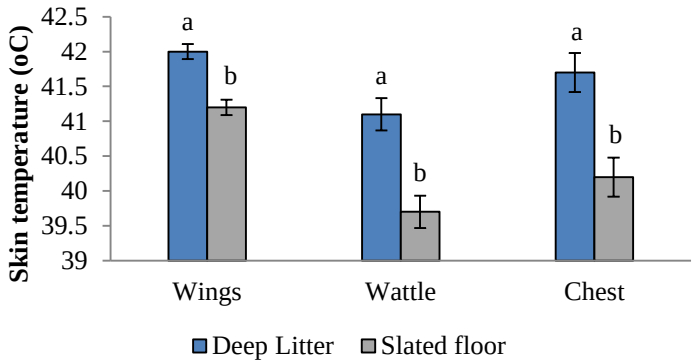

Fig. 2. Effect of floor type on skin temperature under wings, on wattle and chest of broiler chickens during hot-dry season
[a,b] Means represented by bars with different letters differ significantly (P<0.05)

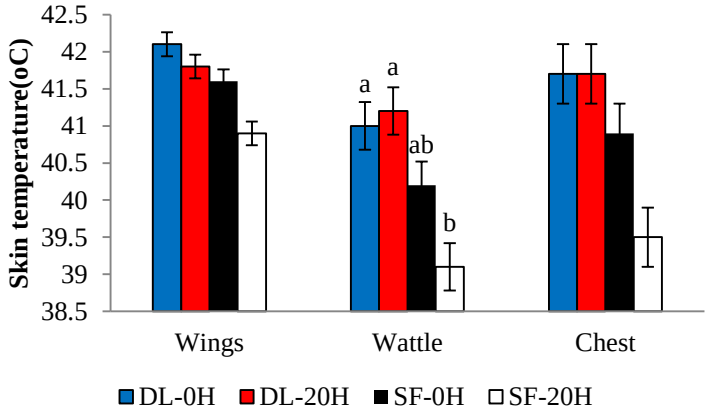

Fig. 3. Interactive effect of honey and floor type on skin temperature under wings, on wattle and chest of broiler chickens during hot-dry season

[a,b] Means represented by bars with different letters differ significantly (P<0.05)

Table 4 shows the effects of honey and floor type on the haematological and plasma biochemical parameters in broiler chickens during hot-dry season. Honey in drinking water had no significant (p>0.05) effect on haematological and plasma biochemical parameters. With the exception of lymphocyte count (p<0.05) that was significantly affected by floor type, other blood parameters were similar (p>0.05) in the 2 floor types. Birds on serrated floor had higher lymphocyte count than those on deep-litter. There were significant interactive effects of honey and floor type on globulin (p<0.05) and AST (p<0.05). Broiler chickens on serrated floor without honey (SF-0H) in drinking water had lower plasma concentration of globulin (2.2 g/dl) than birds on DL-0H, DL-20H and SF-20H (3.4; 3.1; and 3.1g/dl) respectively. The highest value for AST was recorded in DL-20H (93.4 IU/L) while the least was in SF-20H (46.0 IU/L).

Effect of honey and floor type on relative weights of cut-parts in broiler chickens during hot-dry season is presented in Table 5. There were no significant (p>0.05) effect of honey, floor type and/or interaction between the two on dressed and eviscerated weights, relative weights of wings, back, breast, shank, thigh, drumstick, gizzard and liver. However, the effect of floor type was significant on relative weight of head (p<0.05) and neck (p<0.01). Birds on serrated floor had relatively smaller head and neck.

Table 4: Effects of honey and floor type on haematological and plasma biochemical responses in broiler chickens during hot-dry season

Haematological parameter	Honey			Floor			Honey x Floor				
	0H	20H	*p*	DL	SF	*p*	DL-0H	DL-20H	SF-0H	SF-20H	*p*
PCV (%)	26.4±2.30	26.0±2.30	0.910	25.9±2.30	26.5±2.30	0.851	26.5±3.25	25.3±3.25	26.3±3.25	26.8±3.25	0.792
Hb concentration (%)	8.8±0.77	8.7±0.77	0.929	8.6±0.77	8.8±0.77	0.893	8.8±1.09	8.5±1.09	8.7±1.09	8.9±1.09	0.805
RBC	8.6±0.73	8.5±0.73	0.884	8.5±0.73	8.6±0.73	0.884	8.7±1.03	8.2±1.03	8.6±1.03	8.7±1.03	0.812
Platelet	14.4±0.25	14.1±0.25	0.471	14.5±0.25	14.1±0.25	0.275	14.5±0.35	14.4±0.35	14.3±0.35	13.8±0.35	0.675
WBC	10.5±0.31	11.0±0.31	0.248	10.8±0.31	10.7±0.31	0.762	10.2±0.44	11.4±0.44	10.7±0.44	10.6±0.44	0.209
Heterophyl (%)	47.9±2.83	50.3±2.83	0.564	45.0±2.83	53.1±2.83	0.065	45.0±4.00	45.0±4.00	50.8±4.00	55.5±4.00	0.564
Lymphocyte (%)	46.3±2.91	48.9±2.91	0.535	43.0±2.91^{b}	52.1±2.91^{a}	0.046	41.8±4.11	44.3±4.11	50.8±4.11	53.5±4.11	0.976
Monocyte (%)	0.5±0.27	0.8±0.27	0.525	0.5±0.27	0.8±0.27	0.525	0.3±0.38	0.8±0.38	0.8±0.38	0.8±0.38	0.525
Basophil (%)	3.0±0.32	3.2±0.32	0.584	2.9±0.32	3.4±0.32	0.283	2.5±0.45	3.5±0.45	3.3±0.45	3.3±0.45	0.283
Eosinophil (%)	0.0±0.00	0.0±0.00	1.000	0.0±0.00	0.0±0.00	1.000	0.0±0.00	0.0±0.00	0.0±0.00	0.0±0.00	1.000
Heterophil/Lymphocyte	1.2±0.13	1.0±0.13	0.558	1.3±0.13	0.9±0.13	0.079	1.4±0.19	0.9±0.19	1.2±0.19	0.9±0.19	0.641
Biochemical parameter											
Total protein (g/dl)	5.1±0.46	5.9± 0.27	0.182	6.0±0.44	5.2±0.34	0.154	5.9±0.82	6.0±0.43	4.5±0.45	5.9±0.38	0.212
Albumin (g/dl)	2.4±0.29	2.8± 0.22	0.287	2.7±0.27	2.5±0.25	0.536	2.6±0.52	2.9±0.20	2.3±0.35	2.7±0.36	0.892
Globulin (g/dl)	2.7±0.26	3.1±0.18	0.308	3.2±0.25	2.7±0.20	0.081	3.4±0.45^{a}	3.1±0.26^{ab}	2.2±0.18^{b}	3.1±0.27^{a}	0.045
AST (IU/L)	69.2±9.69	65.8±11.59	0.915	77.8±11.06	60.1±9.06	0.223	62.2±11.83^{c}	93.4±17.01^{a}	74.1±14.78^{b}	46.0±11.33^{d}	0.048
ALT (IU/L)	62.9±7.53	76.8±4.98	0.176	65.8±7.81	72.7±5.80	0.472	61.0±13.65	70.6±8.76	64.28±9.41	81.1±5.81	0.705
Uric acid (mg/dl)	7.2±0.40	8.3±0.59	0.160	7.9±0.48	7.6±0.54	0.745	7.5±0.54	8.2±0.84	6.9±0.58	8.4±0.87	0.587

^{a,b}Means within the same row under different factors with different superscripts differ significantly (P<0.05)

Table 5: Effects of honey and floor type on relative weight of cut-parts in broiler chickens during hot-dry season

Carcass yield, %	Honey			Floor			Honey x Floor				
	0H	20H	*p*	DL	SF	*P*	DL-0H	DL-20H	SF-0H	SF-20H	*p*
Liveweight, g	1494±51.7	1556±51.7	0.400	1494±51.7	1556±51.7	0.400	1388±73.1	1600±73.1	1600±73.1	1513±73.1	0.051
Dressed weight, %	79.4±3.36	78.4±3.36	0.844	78.6±3.36	79.2±3.36	0.913	80.1±4.76	78.6±4.76	77.1±4.76	79.7±4.76	0.664
Eviscerated weight, %	73.6±1.75	71.0±1.75	0.303	73.2±1.75	71.4±1.75	0.489	74.1±2.48	73.1±2.48	72.2±2.48	69.8±2.48	0.786
Head, %	2.8±0.09	2.8±0.09	0.873	3.0±0.09^{a}	2.6±0.09^{b}	0.014	3.0±0.13	2.5±0.09	2.9±0.09	2.7±0.09	0.138
Neck, %	4.0±0.14	4.1±0.14	0.776	4.3±0.14^{a}	3.8±0.14^{b}	0.008	4.4±0.19	3.7±0.19	4.3±0.19	3.9±0.19	0.313
Wing, %	8.3±0.19	8.1±0.19	0.490	8.4±0.19	8.0±0.19	0.245	8.4±0.27	8.2±0.27	8.3±0.27	7.9±0.27	0.760
Back, %	15.0±0.42	14.5±0.42	0.411	15.2±0.42	14.4±0.42	0.219	15.8±0.60	14.3±0.60	14.6±0.60	14.5±0.60	0.247
Breastmeat, %	16.3±0.52	16.3±0.52	0.989	16.8±0.52	15.9±0.52	0.230	16.8±0.74	15.8±0.74	16.7±0.74	15.9±0.74	0.923
Shank, %	4.9±0.17	4.9±0.17	0.917	4.9±0.17	4.9±0.17	0.817	4.8±0.24	5.0±0.24	4.9±0.24	4.9±0.24	0.803
Thigh, %	10.0±0.31	9.5±0.31	0.289	9.9±0.31	9.7±0.31	0.656	10.0±0.44	10.0±0.44	9.7±0.44	9.3±0.44	0.706
Drumstick, %	9.8±0.27	9.7±0.27	0.659	9.9±0.27	9.6±0.27	0.435	10.0±0.39	9.7±0.39	9.8±0.39	9.5±0.39	0.884
Gizzard, %	3.7±0.15	3.5±0.15	0.367	3.8±0.15	3.5±0.15	0.166	3.9±0.21	3.5±0.21	3.6±0.21	3.5±0.21	0.582
Liver, %	2.3±0.10	2.2±0.10	0.571	2.3±0.10	2.2±0.10	0.442	2.5±0.15	2.1±0.15	2.1±0.15	2.3±0.15	0.064

^{a,b}Means within the same row under different factors with different superscripts differ significantly (P<0.05)

DISCUSSION

Heat stress is a perennial problem in broiler production in the tropics, reaching climax during the hottest months of the year. Environmental temperature exceeding 30^{o}C is common during hot season in the tropical regions (WMO, 2015). In the present study, the mean temperature was as high as 31.4^{o}C. This is high enough to impose stress upon the birds, and of about 10^{o}C above the upper critical limit of recommended temperature range 18-22^{o}C for optimal productivity. High relative humidity up to 81% such as obtained in the present study further aggravates the debilitating effect of high temperature in broiler chickens (Yahav *et al*., 1995). The adaptation to this new challenge requires redistribution of body reserve of energy and protein to thermoregulation at the cost of decreased growth and reproductive efficiency (Puron *et al*., 1994; Kadim *et al*., 2008).

Hyperthermia is experienced by chickens when the heat load exceeds heat dissipation (Sandercock *et al*., 2001). This is common case in poultry flocks during hot-dry season in the tropics and summer in the temperate regions (Sunil Kumar *et al*., 2011). The present study shows that honey reduced the body thermometric values via rectum and under wings. Previously, it was reported that honey especially up to 20ml per litre is not efficacious in reducing body temperature in broiler chickens Abioja *et al*. (2012). Adekunle *et al*. (2017) even went as far as reporting a negative effect of honey in 28-week-old laying pullet administered honey in drinking water for 16 weeks. A closer look at the work of Adekunle *et al*. (2017) revealed that RT was monitored between 7th and 16th week of honey administration. Results for week 7 to 11 showed either honey group recording significantly lower RT than the control group or having similar values with the control group. Birds in control group eventually had lower RT than the honey-treated group for the rest of the experimental period. Earlier, Abioja *et al*. (2016) stated that prolonged usage of honey may have detrimental effects in laying birds. Lowering the body temperature in broiler chickens relieves the birds from denaturation of proteins which may result in stressed birds. The finding on reduced HR in honey treated group is in agreement with the reports of Adekunle *et al*. (2017).

In the present study, it was found out that honey had no effect on haematological and plasma biochemical parameters examined. This agrees with the report of Osunkeye *et al*. (2016) in a trial to determine the effect of dietary honey supplementation (0, 20 and 30 ml/kg feed) in broiler chickens, except that serum albumin was improved by honey inclusion in feed. The authors reported that honey had no effect on total serum protein, creatine, alanine aminotransferase and cholesterol. The present findings contradict the reports of Osakwe and Igwe (2015) in laying chickens that honey in water reduced MCH, MCHC, lymphocyte, basophil, eosinophil, serum albumin, globulin, cholesterol, urea, creatinine and blood glucose but increased PCV, RBC, haemoglobin concentration, MCV, heterophil count, monocyte count, serum calcium and potassium from the control group. That honey had no effect of blood parameters in this study might be due to the fact that the heterophil/lymphocyte ratio for all the groups (ranging from 0.9 and 1.4) revealed high level of stress. Gross and Siegel (1983) stated that reference values for the heterophil to lymphocyte ratio of about 0.2, 0.5 and 0.8 were suggested as low, optimal and high degrees of stress, respectively in chickens. Honey at the highest dosages in this present study could not control the changes in blood parameters during heat stress occurrence. Effect of floor type was found to only change the lymphocyte count of all

blood parameters in broiler chickens in this study. Birds raised on serrated floor recorded higher lymphocyte count than those on deep-litter floor. Higher lymphocyte count is a sign of less stress level in chickens, will likely reduce the heterophil/lymphocyte ratio (Gross and Siegel, 1983). The reason for higher lymphocyte count in serrated floor group might be adduced to improve ventilation in the pen thereby increasing thermolysis via non-evaporative heat loss mechanism of convention. The existing interaction of honey and floor type on plasma globulin and AST in this study shows that lower values were recorded in birds receiving no honey on serrated floor. There is no report in literature where combining effect of honey and floor type on broilers is given. Heat stress usually causes reduction in blood protein due to ensuing gluconeogesis leading to break down of proteins, lipids and even DNA to generate new glucose molecules during resistant phase of *General Adaptation Syndrome* (GAS) (Selye, 1976; Puron *et al*., 1994; Kadim *et al*., 2008). Blood proteins are lowered in the circulating extracellular fluid because of catabolic effects of corticosterone on the protein molecules. In the present study, birds on serrated floor without honey had the lowest globulin compared to others, suggesting that honey may help in boosting blood globulin. This may be by inhibiting protein breakdown. Heat stress had been known to cause immunosuppression. Blood globulin plays active role in immune system. Similarly, birds on serrated floor that received 20H treatment had the lowest AST. Aspartate amino transferase is an indicator of liver muscle damage. Heat stress increases AST concentration in the plasma.

Renaudeau *et al*. (2012) and Lara and Rostagno (2013) in the list of the adverse effects of environmental temperature above thermoneutral zone had identified alterations in slaughter yields and impairment in meat quality in broiler chickens. This was corroborated by the findings of Zeferino *et al*. (2016) that exposure to heat stress reduced slaughter and carcass weights, increased carcass and abdominal fat percentages, reduced the percentages of breast, liver, heart and proventriculus in Cobb broiler chickens. The same authors did not find possible effect of heat stress in drumstick and thigh percentage in Cobb broiler chickens. However, dietary vitamin C and E supplementation did not affect the relative weight of liver, gizzard, proventriculus, heart, wings, breast and back, except for drumstick and thigh. The present findings of no effects of honey supplementation and different floor type on relative weight of cut-parts and organs in broiler chickens agree with the latter. The only exception was that broiler chickens raised on deep litter floor had heavier head and neck. Reports in literature on the ameliorative effects of heat stress in carcass and organ in broiler chickens are diverse. In the report of Oke *et al*. (2016) involved in trial with different levels of honey from 0 and 60 ml per litre drinking water in broiler chickens during hot season showed significant differences in relative weight of liver, lungs, heart, small intestine, proventriculus, empty gizzard, breast, thigh and whole gastro-intestinal tract in broiler chickens given 20 ml honey per litre water compared with control birds that received no honey supplementation. On the other hand, Abioja *et al*. (2012) stated that honey up to 20 ml per litre water had no effect on slaughter, dressed, breast, gizzard, drumstick, shank and thigh in broiler chickens. The reason for no response of carcass and organs to honey in the present study is not known.

CONCLUSION

In conclusion, the use of honey in drinking was effective in reducing elevated body temperature and respiratory rate but had no influenced on blood parameters and carcass yield in heat-stressed broilers while serrated floor may help increase heat loss in broiler.

For better welfare and thermoregulation during hot spells, honey at 20ml/L drinking water could be offered to broiler chickens. Using serrated floor, rather than deep-litter may help the chickens lose more body heat and thereby cope during hot periods under tropical environment.

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